Financial Repression and Public Finance in a Calibrated General Equilibrium Model

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10 October 2018

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Abstract

This paper uses a simple calibrated general equilibrium model to evaluate the impact of financial repression in the form of non-market placement of public debt. By imposing a requirement for households to hold public debt with a below-market rate of return the government distorts optimal household allocation. Financial repression proceeds as an indirect distortionary taxation, which decreases propensity to consume and increases labor supply. It crowds-out private capital, but has an ambiguous impact on output. The composition of government revenue from taxation changes as well. Tighter financial repression shifts Laffer curves for taxes on labor and consumption down, but increases revenue from capital income taxation. Total budget revenue increases, which allows financing more public goods. We describe the substitutability between financial repression and regular taxation. Abandoning financial repression (increasing the interest rate on public debt) requires a substantial increase in the capital tax rate, which provides a political reasoning for pursuing less visible financial repression. For the U.S., loosening the requirement for private agents to hold public debt should be compensated by heavier regular taxation to keep total budget revenue constant, while European governments can simultaneously decrease the regular tax burden and have smaller public debt to finance the same amount of public goods.

Keywords: financial repression; tax distortions; public debt; Laffer curve.

JEL Classification: E62; H27; H63

1 Introduction

In a broad definition, financial repression is government policy and regulation, which allow the government to raise extra revenue or decrease debt service cost by distorting the market mechanisms setting interest rates. Forms of financial repression are various and in general they are perceived as an indirect taxation of households or financial intermediaries (see, e.g. Reinhart, 2012). The term financial repression was originally introduced by McKinnon (1973) and Show (1973) and then widely applied to show harmful consequences of tight financial regulation for growth and development in LDCs. However, financial repression was also used in practice in developed economies after WWII before the move for deregulation. In the aftermath of the 2007-2009 crisis, under subsequent fiscal stress it increasingly became a modern phenomenon.

The aim of this paper is twofold. First, we introduce financial repression in the form of non-market debt placement into a simple dynamic general equilibrium framework to assess its impact on capital accumulation, labor, production and consumption. We extend the Trabandt and Uhlig (2011) model by an explicit assumption that the government can force households to hold public debt with a below-market rate of interest. The choice of the model is related to our second goal. Trabandt and Uhlig (2011) calibrate their model for the U.S. and a group of 14 European countries (hereafter, EU-14) to estimate Laffer curves for taxes on consumption and capital and labor income. By augmenting their calibration, we show how financial repression affects the corresponding taxes and describe the substitutability between financial repression and regular taxation.

Until recently, literature on financial repression was mostly focused on seigniorage (Roubini and Sala-i-Martin, 1992, 1995; Bencivenga and Smith, 1992), tax evasion (Gupta, 2008; Gupta and Ziramba, 2008, 2010; Bai et al, 2001), and other issues relevant for LDCs, where internal debt markets are thin and governments have to take the cost of external debt finance as given. Governments in developed economies do not face such constraints. They can impose financial repression to reduce the public debt service cost. Furthermore, most of the literature deals with the direct distortionary impact of repression on financial markets. However, in a general equilibrium, distorting interest rate determination should also affect the labor supply and consumption. While the literature provides some estimates of the revenue from financial repression (Giovannini and de Melo, 1993; Reinhart and Sbrancia, 2015) and treats it as an indirect and distortionary taxation, the impact of repression on the base of ordinary taxes is unexplored. Since distortionary taxes interact with each other, by raising extra revenue from financial repression the government can trigger a shortfall of other taxes.

Standard dynamic general equilibrium models typically base on an assumption that households or financial intermediaries hold government bonds voluntarily. It implies that in steady state the rate of return on government bonds equals the rate of time preference of households. Introducing additional macroprudential constraints, such as meeting capital adequacy ratio, can connect the accumulation of private capital to the government debt. However, to the best of our knowledge, macroprudential measures were not explicitly modeled as a policy instrument which the government deliberately exploit to enlarge the demand for public debt. At the same time, there is evidence (see Acharya and Steffen, 2015; Altavilla, Pagano and Simonelli, 2016; Becker and Ivashina, 2014; De Marco and Macchiavelli, 2016; Ongena, Popov and Van Horen, 2016; Van Reit, 2014, among others) that governments have the power to induce private agents to hold more public debt than they would voluntary. This evidence refers to: (1) Macroprudential regulation (Basel III), which provides preferential treatment of the public debt in a calculation of the capital adequacy ratio; (2) Introducing a taxation of transactions with private securities; (3) The government influence on captive financial intermediaries with partial or full state ownership (commercial banks, pension funds, etc.) or heavy moral suasion; and (4) Non-market placement of public debt. While all these measures can enlarge demand for public debt regardless of its riskiness and thus decrease the cost of debt service, the government (or the central bank) has also the power to keep the interest rate on public debt low for a prolonged period of time. These are explicit or implicit caps on deposit rates and various practices under the umbrella of unconventional monetary policy. Taking all this evidence seriously, implies the need to at least relax assumptions of pure voluntarily private holding of public debt and market formation of its interest rate.

In this paper we assume that the government has both the power to compel households to hold public debt in a proportion to private capital and the ability to set the interest rate on debt below the rate of time preference.[1] It is widely believed that keeping the interest rate on public debt low should drive interest rates on private assets down and stimulate the accumulation of productive capital. On the contrary, our model predicts that a decrease in the interest rate on public debt accompanied with the requirement for private sector to hold this debt leads to a higher rate of return on capital. We also show that this policy leads to a crowding-out of private investment, a result corroborated by recent empirical studies (see, e.g., Broner at al, 2014; Popov and Van Horen, 2015). At the same time, we show that the impact of financial repression on output is ambiguous. The ambiguity comes from the shift in labor supply. While tighter repression unambiguously increases the rate of return on productive capital and decreases the demand for labor and the wage, it can increase marginal utility of consumption and labor supply.[2] In turn,

[1]Chari, Dovis and Kehoe (2015) and Scheer, Muller and Kriwoluzky (2017) introduce the similar regulatory requirement, but keep the assumption of market determination of the interest rate on public debt.

[2]This result is in line with the standard theory, predicting a positive response of the labor supply to

higher labor input can increase the output despite crowding-out of private capital. We show that under the utility with constant Frish elasticity the impact of financial repression on output depends on the cross-elasticity of consumption with respect to the wage.

The ambiguity of impact of financial repression corresponds to the revenues from ordinary taxes as well. By augmenting the calibration used in Trabandt and Uhlig (2011), we estimate corresponding Laffer curves for the U.S. economy and the group of European economies. Tighter repression results in lower revenues from taxing consumption and labor, but increases the revenue from capital income taxation. Financial repression generates the direct revenue ("financial repression tax" or "the liquidation effect" introduced by Reinhart and Sbrancia, 2015), which along with the gain in capital income taxation outweigh losses in consumption and labor taxes and provides more finance for government purchases. However, even if one justifies the use of financial repression to provide an additional finance for utility-enhancing public goods, there can be the case of unnecessarily tough repression. By varying both the interest rate on public debt and the requirement to hold the debt, we construct maps of isoclines (Laffer hills) for the net revenue from financial repression and the total funding for government purchases. We show that the U.S. economy is on the "good" side of the Laffer hill, where an increase in the interest rate on public debt requires a compensating tightening of the requirement for private agents to hold public debt. At the same time, European governments could increase the interest rate on public debt and loosen the requirement to hold it without a shortfall of finance for government purchases.

The rest of the paper is organized as follows. In Section 2 we introduce financial repression into a simple neoclassical dynamic general equilibrium model. Section 3 defines competitive equilibrium. In Sections 4 and we study the impact of repression on consumption, labor, capital accumulation and tax revenues in the steady state. Section 6 provides an estimation of government revenues under financial repression for the U.S. and the group of European countries. Section 7 concludes.

2 The model

We study fiscal policy and financial repression in a neoclassical general equilibrium model. The representative household with an infinite life span spends capital and labor income to purchase private consumption goods, pay taxes, accumulate capital and hold government bonds. The government collects consumption, labor and capital taxes and issues bonds to finance the purchase of public goods. The household is compelled to hold government

a negative wealth shock (see, e.g., Chari et al., 2005).

bonds, which can deliver below-market rate of interest, in proportion to the portfolio of assets. This is a simple way to introduce financial repression that allows us to skip explicit modeling of financial intermediaries and consider the household as an ultimate captive agent.

2.1 Household

The household maximizes life-time utility:

$$\max \sum_{t=0}^{\infty} \beta^t \left(u(c_t, n_t) + v(g_t) \right), \tag{1}$$

where β is the subjective discount rate, c_t is the period t private consumption, n_t stands for the hours worked, and g_t is consumption of public goods. Following Trabandt and Uhlig (2011) we introduce felicity function $u(c_t, n_t) = \frac{1}{1-\eta} \left(c_t^{1-\eta} \left(1 - \kappa(1-\eta) n_t^{1+1/\varphi} \right)^{\eta} - 1 \right)$ which has a constant Frisch elasticity of labor supply φ and a constant intertemporal elasticity of substitution η. Additively-separable utility from public goods is $v(g_t) = \psi \ln g_t$.

A household's wealth at the end of period t consists of capital and government bonds, $a_t = k_t + b_t$. Capital accumulation is given by

$$k_t = (1-\delta) k_{t-1} + i_t, \tag{2}$$

where i_t is the period t investment and δ is the rate of capital depreciation. The dynamic budget constraint is

$$\left(1 + \tau_t^c\right) c_t + i_t + b_t = (1 - \tau_t^n) w_t n_t + (1 - \tau_t^k)(r_t - \delta) k_{t-1} + \delta k_{t-1} + R_t^b b_{t-1}, \tag{3}$$

where w_t and r_t are the wage and the rate of return on capital, τ_t^c, τ_t^n and τ_t^k are tax rates for consumption, labor and capital income, and R_t^b is the gross real interest rate on public debt.[3]

2.2 Production

The aggregate output is produced under the constant return to scale technology:

$$y_t = k_{t-1}^{\theta} n_t^{1-\theta}, \ 0 < \theta < 1, \tag{4}$$

Under perfect competition the rate of return on capital and the wage are given by:

$$r_t = \theta \frac{y_t}{k_{t-1}}, \tag{5}$$

$$w_t = (1-\theta) \frac{y_t}{n_t}. \tag{6}$$

[3]Following the literature we assume tax deductible capital depreciation

2.3 Government

The government finances purchases g_t by levying taxes and issuing public debt. The dynamic government budget constraint is

$$g_t + R_t^b b_{t-1} = b_t + T_t^c + T_t^n + T_t^k, \tag{7}$$

where $T_t^c = \tau_t^c c_t$, $T_t^n = \tau_t^n w_t n_t$ and $T_t^k = \tau_t^k (r_t - \delta) k_{t-1}$.

The government pursues financial repression by imposing a requirement for the households to hold government bonds in a proportion to their total wealth

$$b_t = \rho_t (k_t + b_t),\ \ \rho_t \in (0,1), \tag{8}$$

and setting $R_t^b < 1/\beta$.[4] Setting tax rates $\tau_t^k, \tau_t^n, \tau_t^c$ and instruments of financial repression ρ_t and R_t^b determines the government purchases g_t. The choice of policy instruments is only limited by a non-negativity of government purchases. In this specification of fiscal policy, dynamic budget constraint (7) does not require associate no-Ponzi game condition as the placement of public debt is guaranteed by financial repression.

This way of modeling financial repression in a framework without financial intermediaries has its advantages and limitations. On the one hand, this simplification allows us to characterize the overall impact of repression on equilibrium in a tractable way. Indeed, the aforementioned measures of financial repression are too diverse for all of them to be included in one general equilibrium model. While introducing some of them along with explicit modeling of financial intermediation would highlight corresponding specific channels, it does not provide a possibility to estimate the overall impact of repression on government revenues. On the other hand, we have to ignore other (voluntary) motives for holding government debt with a below-market rate of interest as a riskless asset, reserve currency, etc.

3 Competitive equilibrium

Given initial values of all stock variables, a competitive equilibrium is the set of sequences for household allocations $\{c_t, n_t, k_t, b_t,\}_{t=0\ldots\infty}$, factor prices $\{w_t, r_t\}_{t=0\ldots\infty}$ and government purchases $\{g_t\}_{t=0\ldots\infty}$ such that

[4] The essence of financial repression is that under even modest inflation, low nominal interest rate can lead to the negative real interest rate, which "liquidates" the public debt. We study the impact of financial repression in the steady state in a neoclassical model. For this reason we do not introduce money and inflation, but assume that the government and the central bank can control the real interest rate.

(i) The representative household chooses $\{c_t, n_t, k_t, b_t\}_{t=0...\infty}$ to maximize (1) s.t. (2)-(3) and (8), taking factor prices $\{w_t, r_t\}_{t=0...\infty}$ and policy variables $\{\tau_t^n, \tau_t^k, \tau_t^c, \rho_t, R_t^b\}_{t=0...\infty}$ as given.

(ii) Factor prices $\{w_t, r_t\}_{t=0...\infty}$ satisfy (5) and (6).

(iii) Government purchases $\{g_t\}_{t=0...\infty}$ are determined by (7) given $\{\tau_t^n, \tau_t^k, \tau_t^c, \rho_t, R_t^b\}_{t=0...\infty}$.

(iv) Goods market clears: $y_t = c_t + i_t + g_t$.

Combining equations (2), (3) and (11), the Lagrangian for the household's optimization problem is

$$L = \sum_{t=0}^{\infty} \beta^t \left(u(c_t, n_t) + v(g_t) \right) - \lambda_t \left((1+\tau_t^c)c_t + \frac{1}{1-\rho_t} k_t - (1-\tau_t^n) w_t n_t - \left((1-\rho_t) R_t^k - \rho_t R_t^b \right) \frac{k_{t-1}}{1-\rho_t} \right),$$

where $R_t^k = 1 + (1-\tau_t^k)(r_t - \delta)$ is the gross return on capital after taxation.

Corresponding FOCs are

$$-\frac{u_n(c_t, n_t)}{u_c(c_t, n_t)} = \frac{1-\tau_t^n}{1+\tau_t^c} w_t, \tag{9}$$

$$u_c(c_t, n_t) = \beta u_c(c_{t+1}, n_{t+1}) \left[(1-\rho_{t+1}) R_{t+1}^k + \rho_{t+1} R_{t+1}^b \right], \tag{10}$$

where $u_c = c^{-\eta} \left(1 + \kappa(\eta-1) n^{1+1/\varphi}\right)^{\eta}$ and $u_n = -\kappa\eta(1+1/\varphi) c^{1-\eta} \left(1 + \kappa(\eta-1) n^{1+1/\varphi}\right)^{\eta-1} n^{1/\varphi}$. Using equations (9) and (10) it is useful to describe the optimal household's allocation in terms of Frish consumption demand and labor supply functions:

$$c_t(\lambda_t, w_t) = \left(1 + \kappa(\eta-1) \left(\frac{(1-\tau_t^n)(1+\tau_t^c)^{1/\eta-1}}{\kappa\eta(1+1/\varphi)} \right)^{1+1/\varphi} \lambda_t^{(1+\varphi)/\eta} w_t^{1+\varphi} \right) \left[(1+\tau_t^c) \lambda_t \right]^{-1/\eta}, \tag{11}$$

$$n_t(\lambda_t, w_t) = \left[\frac{(1-\tau_t^n)(1+\tau_t^c)^{1/\eta-1} \lambda_t^{\varphi/\eta}}{\kappa\eta(1+1/\varphi)} \right] w_t^{\varphi}. \tag{12}$$

Financial repression affects consumption and labor supply via changes in the wage and shifts in the marginal utility of consumption (Lagrange multiplier λ).

4 Steady state

The steady-state rate of return on capital is given by[5]

$$r = \frac{1-\beta}{\beta(1-\tau^k)} + \delta + \frac{\rho}{(1-\rho)(1-\tau^k)} \left(\frac{1}{\beta} - R^b \right). \tag{13}$$

[5] To denote steady-state values we omit the time index.

The first and the second terms in the LHS of equation (12) correspond to the standard Euler equation. If $\rho = 0$ or $R^b = {}^1\!/\!_\beta$, then the gross rate of return on capital after taxation $R^k = 1 + (1 - \tau^k)(r - \delta)$ equals ${}^1\!/\!_\beta$. The third term characterizes the distortionary impact of financial repression. By setting $\rho > 0$ and $R^b < {}^1\!/\!_\beta$, the government distorts capital market equilibrium. On the one hand, households become eager to invest in capital as this investment is forcefully accompanied by additional holding of the public debt with the below-market rate of interest. On the other hand, equation (13) states that the gross rate of return of the household's assets portfolio $(1 - \rho) R^k + \rho R^b$ equals to ${}^1\!/\!_\beta$. Thus, R^k should be higher than ${}^1\!/\!_\beta$. The tighter the repression, the higher the rate of return on capital. This result challenges the conventional wisdom that by decreasing the interest rate on the public debt via open market operations, the central bank drives the rate of return on private assets down. This is only true if the holding of public debt is purely voluntary. Under the forced holding of public debt, lower rate of return on debt drives the rate of return on private assets up.

By putting upward pressure on the rate of return on capital financial repression decreases the capital-output ratio ${}^k\!/\!_y = \theta r^{-1}$, the capital-labor ratio ${}^k\!/\!_n = \left({}^k\!/\!_y\right)^{1/(1-\theta)}$ and the wage $w = (1 - \theta) \left({}^r\!/\!_\theta\right)^{-\theta/(1-\theta)}$. The impact of financial repression on capital, labor, output and consumption is ambiguous. Start with wealth-output ratio, consumption-output ratio (average propensity to consume) and labor as their reaction to financial repression helps to describe its impact on other variables. Budget constraint (3) in the steady state and requirement (8) imply consumption-output ratio as a function of the wealth-output ratio:

$$\frac{c}{y} = (1 - \theta) \frac{1 - \tau^n}{1 + \tau^c} + \frac{1 - \beta}{\beta (1 + \tau^c)} \frac{a}{y}. \tag{14}$$

Equation (14) defines standard consumption function with unit marginal propensity to consume out of disposable labor income $(1 - \tau^n) wn = (1 - \theta)(1 - \tau^n) y$ and the marginal propensity to consume out of wealth ${}^1\!/\!_\beta - 1$. Next step is to consider the wealth-output ratio:

$$\frac{a}{y} = \frac{\theta (1 - \tau^k)}{(1 - \rho)\left(\left(\frac{1}{\beta} - 1\right) + \delta (1 - \tau^k)\right) + \rho\left(\left(\frac{1}{\beta} - 1\right) + (1 - R^b)\right)}. \tag{15}$$

Proposition 1. ${}^a\!/\!_y$ and ${}^c\!/\!_y$ increase in R^b $\forall$ $\rho > 0$, increase in ρ if $1 - \left(1 - \tau^k\right)\delta < R^b < {}^1\!/\!_\beta$, and decrease in ρ if $R^b < 1 - (1 - \tau^k)\delta$.

Proof: This straightforwardly follows from equations (14) and (15). ∎

The intuition behind this result is straightforward. The denominator in the LHS of equation (15) is the adjusted net weighted annual discount rate. Absent capital depreciation and financial repression, it equals ${}^1\!/\!_\beta - 1$. The adjustment for the tax-deductible capital depreciation is $\delta(1-\tau^k)$. The term $1-R^b$ adjusts annual discount rate for the net loss from financial repression. On the one hand, the lower R^b, the higher net loss from financial repression, the higher weighted annual discount rate. It implies lower wealth-output and consumption-output ratios. On the other hand, the impact of financial repression in terms of higher ρ depends on the relationship between two adjustment terms in the weighted annual discount rate. The inequality $1-R^b<(1-\tau^k)\,\delta$ means that the loss from financial repression is smaller than the loss from capital depreciation. Thus, an increase in ρ implies a decrease in the adjusted weighted annual discount rate, which leads to higher wealth-output and consumption-output ratios.

The relationship between $1-R^b$ and $\delta(1-\tau^k)$ implies different regimes of financial repression.[6]

Definition:
"The mild financial repression regime" corresponds to the range $1-\left(1-\tau^k\right)\delta<R^b<{}^1\!/\!_\beta$.
"The tough financial repression regime" corresponds to $R^b<1-(1-\tau^k)\,\delta$.

While the wage unambiguously decreases under tighter financial repression, the change in labor is ambiguous. The utility with constant Frish elasticity implies that the quantity of labor supplied is proportional to w^φ. However, the labor supply (12) shifts with changes in the Lagrange multiplier $\lambda=(1+\tau^c)^{-1}u_c(c,n)$. On the other hand, by decreasing capital-output ratio, repression also shifts down the demand for labor. Using FOCs (9) and (10) for household's maximization problem and (5) and (6) we can derive:

$$\frac{c}{y}=\frac{1-\theta}{1+\frac{1}{\varphi}}\frac{1-\tau^n}{1+\tau^c}\left(1-\frac{1}{\eta}+\left(\kappa\eta n^{1+\frac{1}{\varphi}}\right)^{-1}\right). \tag{16}$$

Equation (16) implies a negative relation between n and ${}^c\!/\!_y$. Thus, the impact of financial repression on labor straightforwardly follows from the Proposition 1.

Corollary 1. n always decreases in R^b, decreases in ρ in the regime of mild repression and increases in ρ in the regime of tough repression.

If tighter financial repression decreases average propensity to consume, it also stimulates households to work more. Before evaluating the impact of financial repression on capital and output, let us point-out the impact of financial repression on two important characteristics. First is the cross-elasticity of consumption with respect to the wage, which is given by

$$\epsilon_w^c=\varphi\left(1-\frac{1}{\eta}\right)(1-\theta)\,\frac{1-\tau^n}{1+\tau^c}\left(\frac{c}{y}\right)^{-1}. \tag{17}$$

[6] Note that absent tax-deductible capital depreciation, the threshold value of R^b is 1, that is, zero net real interest rate. For the calibration which we employ in Section 6, corresponding threshold values for R^b are 0.947 for the U.S. and 0.953 for EU-14.

This cross-elasticity plays a crucial role in the explanation of business cycles (see, e.g. Hall, 2009) and in the characterization of the impact of financial repression on output and tax revenues. In turn, the cross-elasticity is negatively related to the consumption-output ratio. Under reasonable assumption $\eta > 1$, the following corollary directly follows from Proposition 1:

Corollary 2. ϵ_w^c always decreases in R^b, decreases in ρ in the regime of mild repression and increases in ρ in the regime of tough repression.

In the tough regime, tighter financial repression makes consumption more sensitive to changes in the wage, which should amplify the impact of repression on consumption, capital accumulation and output. In the mild regime, the sensitivity becomes smaller.

Financial repression also affects the composition of a household's disposable income, which is important for consumption-saving decisions. Let α denote the share of income from holding assets in the total disposable income:

$$\alpha = \frac{\frac{1-\beta}{\beta}a}{(1-\tau^n)\,wn + \frac{1-\beta}{\beta}a}. \tag{18}$$

Corollary 3. α always increases in R^b, increases in ρ in the regime of mild repression and decreases in ρ in the regime of tough repression.

By writing $wn = (1-\theta)\,y$ we see that the share α is an increasing function of a/y and reacts to tighter financial repression in the same direction as c/y. As we will see, this adjustment in the composition of disposable income partially compensates the change in the sensitivity of consumption with respect to the wage. It is also useful to note, that equations (14), (17) and (18) imply the inequality $\epsilon_w^c < \varphi(1-\alpha)$.

Now we are ready to describe the impact of financial repression on capital, output and tax revenues:

Proposition 2.

1. Tighter financial repression in the form of lower R^b or in the form of higher ρ always decreases k .

2. Tighter financial repression in the form of lower R^b decreases y iff $\epsilon_w^c < 1 + \varphi\left(1 - \alpha\frac{1-\theta}{\theta}\right)$.
Tighter financial repression in the form of higher ρ decreases y iff $\epsilon_w^c < 1 + \varphi\left(1 - \alpha\gamma\frac{1-\theta}{\theta}\right)$,
where $\gamma = (1-\rho)\,\dfrac{1-\delta(1-\tau^k)-R^b}{1/\beta - R^b}$.

Proof: See Appendix.

As it follows from Proposition 2, while financial repression always inhibits capital accumulation, it can increase the output if only it sufficiently increases the supply of labor. Tighter financial repression in the form of lower R^b always decreases the wage rate and the propensity to consume and increases the labor. The strength of its impact on labor depends on the cross-elasticity of consumption with respect to the wage. If the cross-elasticity is sufficiently high, then a decrease in the propensity to consume corresponds to an increase in labor which is sufficient to increase output despite decrease in capital.

As the impact of tighter repression in the form of higher ρ on labor is ambiguous, so is its impact on output. In the regime of mild financial repression, $\gamma < 0$ and thus higher ρ implies lower labor, capital and output. In the regime of tough repression, higher ρ increases the labor and can increase the output.[7]

Now let us turn to the impact of financial repression on government revenues.

5 Financial repression and public finance

Financial repression acts as an indirect tax. Purposefully, financial repression provides the government budget with an additional revenue. However, it can either decrease or increase the revenue from ordinary taxes because of its distortionary impact on capital, labor, and consumption. This makes the impact of financial repression on endogenous government purchases ambiguous. Moreover, as many other taxes, the revenue from financial repression has a Laffer-curve property. It is a limited source of extra revenue. And the same amount of this revenue can be achieved by either mild or tough repression. In other words, there could be the case of unnecessarily tough repression.

Start with the impact of financial repression on ordinary taxes.

Proposition 3.

1. Tighter financial repression in the form of lower R^b decreases consumption tax T^c iff $\epsilon^c_w < 1 + \varphi \dfrac{\theta}{\theta + (1-\theta)\alpha}$. Tighter financial repression in the form of higher ρ decreases consumption tax T^c iff $\epsilon^c_w < 1 + \varphi \dfrac{\theta}{\theta + (1-\theta)\alpha\gamma}$.

2. Tighter financial repression in the form of lower R^b decreases labor tax T^n iff $\epsilon^c_w < 1 + \varphi \left(1 - \alpha \dfrac{1-\theta}{\theta}\right)$. Tighter financial repression in the form of higher ρ decreases labor tax T^n iff $\epsilon^c_w < 1 + \varphi \left(1 - \alpha\gamma \dfrac{1-\theta}{\theta}\right)$.

[7] For the calibration that we employ in Section 6, for the U.S., ϵ^c_w is 0.45, while the threshold $1 + \varphi\left(1 - \alpha\frac{1-\theta}{\theta}\right)$ is 1.79 and the threshold $1 + \varphi\left(1 - \alpha\gamma\frac{1-\theta}{\theta}\right)$ is 2.26, which means that tighter repression either in the form of lower R^b or in the form of higher ρ reduces the output. The same result holds for EU-14 ($\epsilon^c_w = 0.43$, $1+\varphi\left(1 - \alpha\frac{1-\theta}{\theta}\right) = 1.74$, $1+\varphi\left(1 - \alpha\gamma\frac{1-\theta}{\theta}\right) = 2.31$). However, the case of output increasing financial repression does not seem to be unrealistic. For example, the reasonable set of parameters $\eta = 15$, $\varphi = 4$, $\theta = 0.3$ and policy instruments $\tau^k = 0.36$, $\tau^n = 0.48$, $\rho = 0.25$ and $R^b = 0.99$ satisfies the condition for the positive impact of tighter financial repression in the from of lower R^b or higher ρ on output.

3. Tighter financial repression in the form of lower R^b decreases capital tax T^k iff $\epsilon_w^c < 1 + \varphi\left(1 - \alpha\frac{(1-\theta)(r-\delta)}{\theta r - \delta}\right)$. Tighter financial repression in the form of higher ρ decreases capital tax T^k iff $\epsilon_w^c < 1 + \varphi\left(1 - \alpha\gamma\frac{(1-\theta)(r-\delta)}{\theta r - \delta}\right)$.
4. Tighter financial repression in the form of lower R^b decreases the sum of ordinary taxes $T = T^c + T^n + T^k$ iff $\epsilon_w^c < 1 + \varphi\left(1 - \alpha\left(\frac{\theta}{1-\theta} + \Gamma\right)^{-1}\right)$.
   Tighter financial repression in the form of higher ρ decreases the sum of ordinary taxes T iff $\epsilon_w^c < 1 + \varphi\left(1 - \alpha\gamma\left(\frac{\theta}{1-\theta} + \Omega\right)^{-1}\right)$, where
   $\Gamma = \frac{\alpha\tau^c\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} - \tau^k\theta}{\tau^c\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^n(1-\theta) + \tau^k\theta\left(1-\delta(1-\rho)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right)}$ and $\Omega = \frac{\gamma\alpha\tau^c\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} - \tau^k\theta}{\tau^c\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^n(1-\theta) + \tau^k\theta\left(1-\delta(1-\rho)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right)}$.

Proof: See Appendix.

While Proposition 3 provides conditions when financial repression can increase revenues from consumption and labor income taxation, under realistic calibration (see Section 6 below) the impact of repression on these taxes is negative.[8] At the same time, conditions for the positive impact of tighter financial repression on capital income tax are met for the U.S. and EU-14. Indeed, even if tighter repression crowds-out private investment, its positive impact on the rate of return on capital can outweigh the decrease in the stock of capital and result in a higher base of capital income taxation. Note that if $\theta r - \delta < 0$, then a decrease in R^b always increases T^k and an increase in ρ also increases T^k in the regime of tough financial repression with $\gamma > 0$.[9]

Consider next the direct revenue from repression. Under conventional interpretation, financial repression decreases the debt service cost or, if $R^b < 1$, it liquidates the debt (see., e.g. Reinhart and Sbrancia, 2015). However, the fact that the government coerce households to hold public debt questions this interpretation. Moreover, it makes the impact of financial repression on public debt ambiguous.

Proposition 4. Tighter financial repression in the form of lower R^b decreases b. Tighter financial repression in the form of higher ρ increases b iff $\epsilon_w^c < 1 + \varphi\left(1 + \frac{\alpha(1-\theta)\gamma\rho}{1-\rho-\theta+\gamma(1-\theta)}\right)$.
Proof: See Appendix.

Since $b = \frac{\rho}{1-\rho}k$, the impact of financial repression on steady-state public debt can be deduced from its impact on capital accumulation. For a given ρ, a decrease in R^b leads to a decrease in k, and thus to a decrease in b. It means that tighter financial repression does not liquidate the debt from the budget arithmetic perspective, but decreases it in

[8] Comments on how these results are connected to the change in ϵ_w^c and α apply here in the same way as in the case of Proposition 2. Note, that the impact of repression on taxable labor income $wn = (1-\theta)y$ corresponds with its impact on output.

[9] For the U.S., $\theta r - \delta$ is -0.04 (-0.03 for EU-14).

conjunction with a depressed capital accumulation. For a given R^b, an increase in ρ leads to a decrease in k, which makes the impact on $b = \frac{\rho}{1-\rho}k$ ambiguous.[10]

We can write the steady-state budget constraint (7) as

$$g + \frac{1-\beta}{\beta}b = \left(\frac{1}{\beta} - R^b\right)b + T^c + T^n + T^k, \tag{19}$$

and define the net revenue from financial repression as $T^b = \left(\frac{1}{\beta} - R^b\right)b$, which is the steady-state analogue to the "financial repression tax" discussed in Reinhart and Sbrancia (2015). Define the respective implicit tax rate $\tau^b = \frac{1}{\beta} - R^b$. Net revenue from financial repression has the Laffer curve property.

Proposition 5. $T^b = T^b(\tau^b, \rho)$ is a hump-shaped function of τ^b and ρ.
Proof: See Appendix.

It follows, that for a given ρ, there are up to two levels of R^b, which provide a certain amount of T^b. And vice versa, for a given R^b, there are up to two levels of ρ, which correspond to some T^b. The intuition behind this result is straightforward. On the one hand, an increase in the rate of financial repression tax, τ^b, decreases the base of this tax, b. On the other hand, while an increase in ρ does not affect the rate of financial repression tax, it can either increase or decrease the base.

Since we consider financial repression in terms of two policy instruments, ρ and R^b, it is important to characterize these instruments in terms of substitutability or complementarity for providing a certain amount of T^b. Moreover, since financial repression changes revenues from ordinary taxes, it is useful to investigate the substitutability of these instruments with respect to the sum of ordinary taxes, $T = T^c + T^n + T^k$, the total funding of government purchases, g, and "notional" government spending, $g + \frac{1-\beta}{\beta}b$, which is the sum of government purchases and debt service cost at the market interest rate.

Proposition 6.

1. $\frac{d\rho}{dR^b}\big|_{T^b=const} < 0$ iff $\underline{\nu} < \epsilon_w^c < \overline{\nu}$.
2. $\frac{d\rho}{dR^b}\big|_{T=const} < 0$ iff $\underline{\upsilon} < \epsilon_w^c < \overline{\upsilon}$.
3. $\frac{d\rho}{dR^b}\big|_{g=const} < 0$ iff $\underline{\sigma} < \epsilon_w^c < \overline{\sigma}$.
4. $\frac{d\rho}{dR^b}\big|_{g+\frac{1-\beta}{\beta}b=const} < 0$ iff $\underline{\varsigma} < \epsilon_w^c < \overline{\varsigma}$.

Proof: See Appendix.

[10]Note, that our interpretation of the impact of financial repression on public debt corresponds to the steady state, while the liquidation effect of financial repression, which is discussed in Reinhart and Sbrancia (2015), corresponds to the transitory dynamics.

The proposition implies that two financial repression instruments can be either substitutes or complements.[11] Since ϵ_w^c is monotonically decreasing in R^b , there is a range of values of R^b, such that an increase in R^b should be accompanied by a decrease in ρ to keep the net revenue from financial repression constant. That is, financial repression can be loosened in terms of both policy instruments and still provide the same T^b. The same conclusion holds for the sum of ordinary taxes, the government purchases and the notional government spending. The proposition does not imply any specific relation between intervals $[\underline{\nu}, \overline{\nu}]$, $[\underline{\upsilon}, \overline{\upsilon}]$, $[\underline{\sigma}, \overline{\sigma}]$ and $[\underline{\varsigma}, \overline{\varsigma}]$. For example, if ρ and R^b are substitutes in terms of providing a certain amount of T^b, it does not necessarily mean that they are substitutes in terms of funding a certain amount of g. In next section we do some quantitative assessment of the impact of financial repression on public finance for the U.S. and EU-14. In particular, we show that the complementarity of financial repression instruments (the case of "too much repression") is not hypothetical.

6 Calibrated Laffer curves and revenue from financial repression

To evaluate the impact of financial repression on tax revenues we use the same calibration and baseline tax policy sets (see Table 1) as in Trabandt and Uhlig (2011) for the U.S. and EU-14. The calibration is augmented to deal with financial repression. The choice of ρ corresponds to public debt to GDP ratio of 0.96 for the U.S. and 0.93 for EU-14.[12] The equilibrium without repression corresponds to the case $R^b = {}^1\!/\!_\beta$. To evaluate the impact of financial repression, we consider $R^b = 0.99$, which corresponds to the case of mild repression in Section 4.

Table 1. Calibration and the baseline tax policy sets.

	η	φ	κ	τ^c	τ^k	τ^h	θ	δ	β	ρ	R^b
The U.S.	2	1	3.46	0.05	0.36	0.28	0.35	0.083	0.985	0.25	0.99
EU-14				0.17	0.33	0.41	0.38	0.07		0.20	

While our theoretical setup does not allow for the impact on the growth rate of the economy, we can estimate the impact of repression on the steady-state output, which is lowered by 5.2 for the U.S. and 4.8 for EU-14 with respect to the no-repression equilibrium. At the same time financial repression is indeed effectual for raising budget finance. It

[11] We do not address analytically the issue of substitutability between financial repression and ordinary taxes, but provide some calibration-based estimates in Section 6.

[12] The group of European countries is the same as in Trabandt and Uhlig (2011). Debt to GDP ratios are form AMECO database: http://ec.europa.eu/economy_finance/ameco/.

finances 9.1 of notional government spending, $g + \frac{1-\beta}{\beta} b$, which is 2.5 of output for the U.S. (6.2 and 2.4, respectively, for EU-14). It increases both ${}^{g}\!/\!{}_{y}$ by 3.7 and g by 10.8 for the U.S. (correspondingly, by 3.3 and 4.5 for EU-14). While in this paper we do not address the issue of whether financial repression is a part of optimal Ramsey allocation, one should not preclude that it can be welfare-improving.[13] Indeed, if actual ordinary tax rates do not correspond to the optimal Ramsey allocation, changing them or introducing financial repression can increase the welfare. As the principle rationale for repression is that it provides additional finance for the utility-enhancing purchases of public goods, the rate of substitution between public and private goods plays an important role. For the utility from public goods $v(g) = \psi \ln g$, financial repression increases welfare if $\psi > 0.24$ for the U.S. ($\psi > 0.54$ for EU-14).

Figs. 1-4 show the estimated impacts of financial repression on tax revenues. Fig. 1(a) demonstrates a shift in the Laffer curve for capital income tax when the government sets $R^b < {}^{1}\!/\!{}_{\beta}$. An increase in tax revenue in relation to the no-repression case, $R^b = {}^{1}\!/\!{}_{\beta}$, is noticeable both for the U.S. and EU-14. Tightening financial repression by setting higher ρ (see Fig. 1(b)) also leads to an increase in the capital income tax. At the same time, tighter financial repression in terms of either lower R^b or higher ρ shifts down Laffer curves for labor tax (Fig. 2) and consumption tax (Fig. 3), which is the case both for the U.S. and EU-14. For this calibration, financial repression decreases consumption and the productivity of labor, which is not compensated by higher labor supply. Finally, Fig. 4 depicts Laffer hills for capital and labor taxes for the U.S. (isoclines in space of tax rates τ_t^n and τ_t^k) for the case of repression $R^b < {}^{1}\!/\!{}_{\beta}$ (Fig. 4(a)) and no-repression $R^b = {}^{1}\!/\!{}_{\beta}$ (Fig. 4(b)). Financial repression does not alter the form of the hill, only slightly changes its shape. The U.S. economy becomes higher on the "good" side of the hill, where capital and labor taxes are substitutes for providing revenue and higher tax rates lead to higher revenue.

Fig. 5(a) and Fig. 5(b) depict Laffer curves for the net revenue from financial repression. Both the U.S. and EU-14 are on the good side of the curve. However, as we stressed in previous section, it does not preclude the possibility of a "too much repression". Figs. 6-8 show estimated Laffer hills in the space of two policy instruments for the net revenue from financial repression, notional government spending and government purchases. Indeed, while both the U.S. and EU-14 are on the good side of the Laffer hill for T^b and

[13] One can easily solve the Ramsey allocation problem to show that the optimal choice of tax rate is $\tau^k = \frac{\rho}{1-\rho}\frac{\beta R^b - 1}{1-\beta}$. In the absence of financial repression, i.e., for $\rho = 0$ or $R^b = {}^{1}\!/\!{}_{\beta}$, optimal tax rate is $\tau_t^k = 0$, which is the classical Chamley (1986) and Judd (1985) result. If the government pursues financial repression by setting $R^b < {}^{1}\!/\!{}_{\beta}$ and $\rho > 0$, then the government should subsidize the capital, $\tau^k < 0$. And, vice verse, if the capital income is taxed at the rate $\tau^k > 0$, then the rate of return on government bonds should be subsidized, $R^b > {}^{1}\!/\!{}_{\beta}$.

$g + \frac{1-\beta}{\beta} b$, EU-14 is on the wrong side of the Laffer hill for g, where financial repression instruments are complements. We will continue the discussion of this issue below.

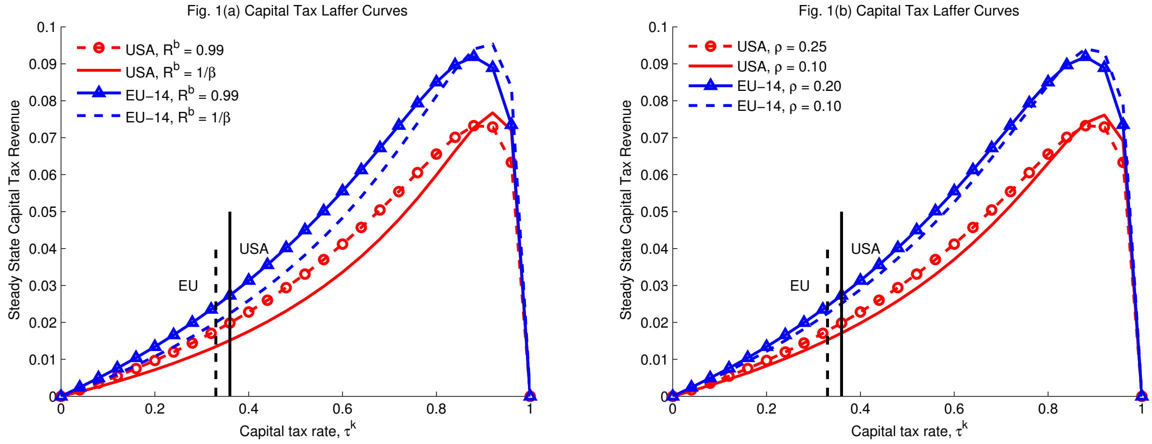

Fig.1. The impact of financial repression ($R^b < 1/\beta$) on the capital tax Laffer curves

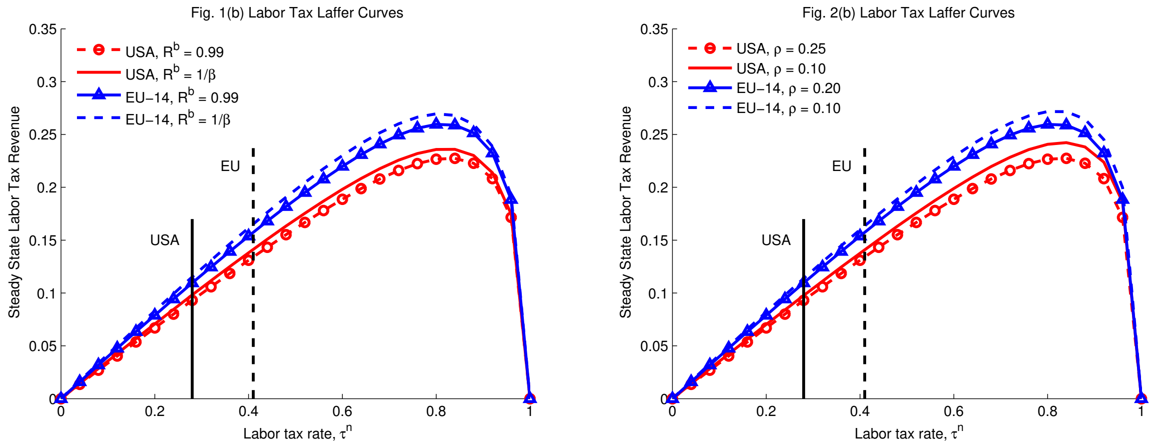

Fig.2. The impact of financial repression (higher ρ) on the labor tax Laffer curves

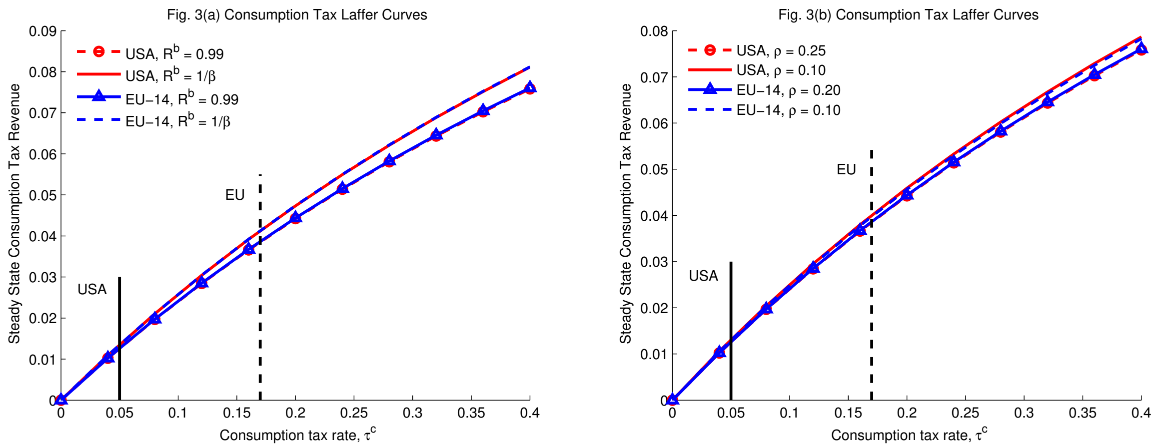

Fig.3. The impact of financial repression on the consumption tax Laffer curves

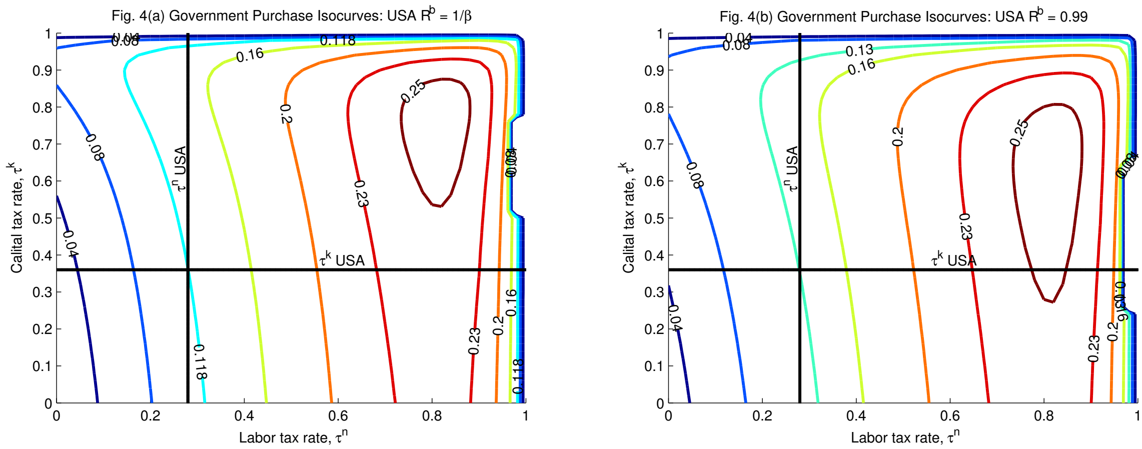

Fig.4. The impact of financial repression on Laffer hills for capital and labor taxes

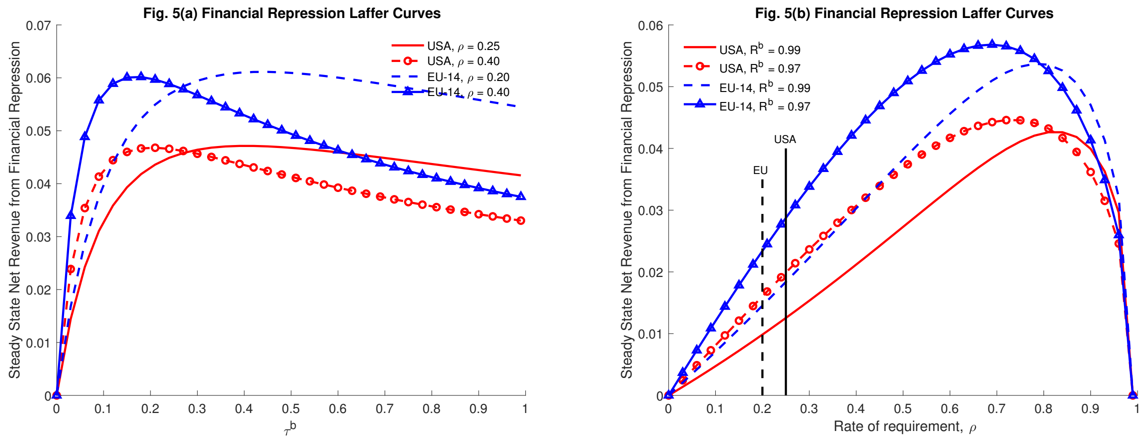

Fig.5. Laffer curves for the net revenue from financial repression

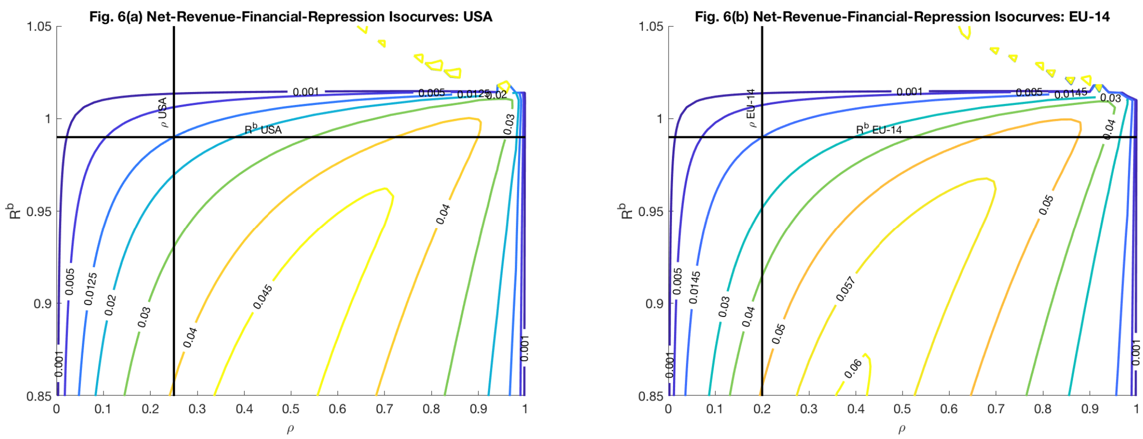

Fig.6. Laffer hills for the net revenue from financial repression

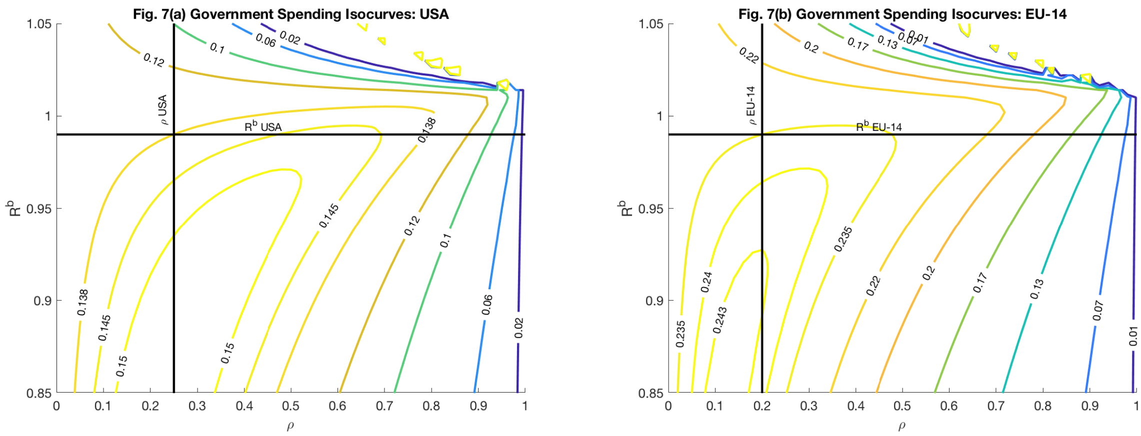

Fig.7. Laffer hills for the notional government spending

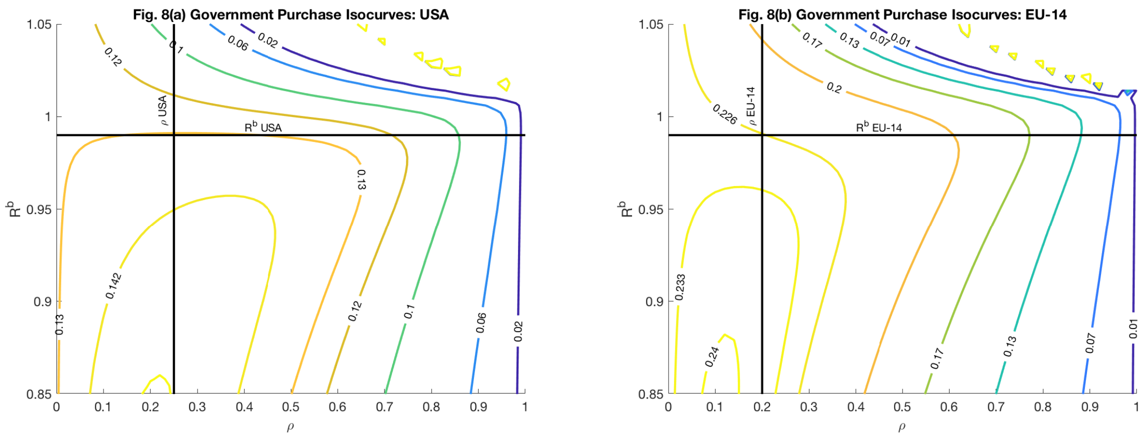

Fig.8. Laffer hills for the government purchases

Finally, we estimate the substitutability or complementarity between various policy instruments. Table 2 provides marginal rates of substitution between pairs of instruments $\{R^b, \rho, \tau^c, \tau^k, \tau^n\}$ keeping government purchases constant. Several observations are particularly interesting.

First, both for the U.S. and EU-14, the instrument of financial repression R^b and regular tax rates are substitutes: to keep government purchases constant, looser financial repression should be substituted by heavier regular taxes. The striking quantitative result is the high absolute value of the rate of substitution between R^b and τ^k. Loosening financial repression, $dR^b > 0$, requires a relatively high compensation in terms of increasing τ^k (1 p.p. increase in R^b requires 9.03 p.p. increase in τ^k for the U.S. and 7.78 p.p. increase in τ^k for EU-14). This provides a political economy rationale why governments tend to impose financial repression as an indirect (hidden) taxation instead of taxing capital income directly.

Second, while for the U.S., the instrument of financial repression ρ and regular taxes are substitutes, i.e., loosening the requirement for private agents to hold public debt should be compensated by heavier regular taxation to keep the government purchases constant, for EU-14, ρ and regular taxes are complements. This means that financial repression is unnecessary tough. The governments can decrease the regular tax burden and have smaller public debt to finance the same amount of public goods.

Table 2. Estimated marginal rates of substitution between policy instruments keeping government purchases constant for the U.S. (EU-14 in brackets)

	dR^b	$d\rho$	$d\tau^c$	$d\tau^k$	$d\tau^n$
dR^b		**152.72**	**1.66**	**9.03**	**1.31**
		(-10.88)	(1.56)	(7.78)	(1.05)
$d\rho$	**0.007**		**−0.01**	**−0.06**	**−0.01**
	(-0.09)		(0.14)	(0.71)	(0.10)
$d\tau^c$	**0.60**	**−92.20**		**−5.45**	**−0.79**
	(0.64)	(6.95)		(-4.96)	(-0.67)
$d\tau^k$	**0.11**	**−16.92**	**−0.18**		**−0.15**
	(0.13)	(1.40)	(-0.20)		(-0.13)
$d\tau^n$	**0.76**	**−116.25**	**−1.26**	**−6.87**	
	(0.95)	(10.35)	(-1.49)	(-7.40)	

Third, two instruments of financial repression, R^b and ρ, are substitutes for the U.S. and complements for EU-14. Indeed, the U.S. economy is on the good side of the Laffer hill for the the government purchases (see Fig. 8(a)), EU-14 economies are on the wrong side of the hill (see Fig. 8(b)). The U.S. government can, for example, loosen financial repression by increasing the interest rate on public debt and compensate this by enlarging demand for the debt. At the same time, to keep the government purchases constant in EU-14 economies, financial repression should be either tightened or loosen in both directions (a lower interest rate on the debt should be accompanied by heavier requirement to hold the debt, and vice verse). Another interesting (quantitative) result is the high by absolute value rate of substitution between R^b and ρ. For the U.S., even small increase in the interest rate on public debt requires a huge enlargement of its private holding.

7 Conclusion

While the shift from traditional to unconventional monetary policy sparked a wide discussion of the change in the future of monetary system, the "return of financial repression" stays mostly silent despite its important consequences both for the fiscal stance and economic dynamics. Being a form of indirect and distortionary taxation, financial repression alters the equilibrium allocation and interacts with other taxes. We introduce financial repression as the requirement for households to hold government debt with a below-market rate of interest into a simple general equilibrium model. First, we describe its non-trivial impact on optimal household's allocation. Financial repression decreases the propensity to consume and induces households to increase the supply of labor. Financial repression crowds-out productive capital, but its impact on output is ambiguous.

Second, we calibrate the model for the U.S. and a group of European economies and show that tighter financial repression vastly increases total government revenues. While it shifts Laffer curves for consumption and labor taxes down, it increases the revenue from capital income taxation. If the revenue from repression finances valuable public goods, it can be welfare-improving. We also address the issue of whether financial repression can be easily abandoned. Paying higher interest rate on public debt requires a relatively large increase in the capital tax rate, which provides a political reasoning for pursuing less visible financial repression. At the same time, the scope of financial repression in terms of compelled holding of public debt may be exaggerated. While, for the U.S., the government cannot maintain the level of expenditures and decrease the public debt without increasing revenues from regular taxes, European economies can be provided with the same amount of public goods under both easier regular tax burden and smaller public debt.

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A Appendix. Proof of Propositions

A.1 Proof of Proposition 2

The Cobb-Douglas production function implies:

$$\epsilon_x^y = \frac{\theta}{1-\theta}\epsilon_x^{k/y} + \epsilon_x^n, \qquad (A.1.1)$$

$$\epsilon_x^k = \frac{1}{1-\theta}\epsilon_x^{k/y} + \epsilon_x^n, \qquad (A.1.2)$$

where ϵ_x^z is the elasticity of z with respect to x. Elasticities of the capital-output ratio with respect to the instruments of financial repression are:

$$\epsilon_{R^b}^{k/y} = \frac{R^b b/y}{(1-\tau^k)\theta} > 0, \qquad (A.1.3)$$

$$\epsilon_{\rho}^{k/y} = -\frac{(1/\beta - R^b)b/y}{(1-\rho)(1-\tau^k)\theta} < 0. \qquad (A.1.4)$$

By combining equations (8), (14) and (16), we get relations between ϵ_x^n and $\epsilon_x^{k/y}$:

$$\epsilon^{n}_{R^b} = -\frac{\alpha\varphi}{1+\varphi-\epsilon^{c}_{w}}\epsilon^{k/y}_{R^b}, \tag{A.1.5}$$

$$\epsilon^{n}_{\rho} = -\frac{\alpha\gamma\varphi}{1+\varphi-\epsilon^{c}_{w}}\epsilon^{k/y}_{\rho}. \tag{A.1.6}$$

By substituting equations (A.1.3)-(A.1.6) into (A.1.1) and (A.1.1), we get

$$\epsilon^{y}_{R^b} = \left(\frac{\theta}{1-\theta} - \frac{\alpha\varphi}{1+\varphi-\epsilon^{c}_{w}}\right)\epsilon^{k/y}_{x}, \tag{A.1.7}$$

$$\epsilon^{y}_{\rho} = \left(\frac{\theta}{1-\theta} - \frac{\alpha\gamma\varphi}{1+\varphi-\epsilon^{c}_{w}}\right)\epsilon^{k/y}_{\rho}, \tag{A.1.8}$$

$$\epsilon^{k}_{R^b} = \left(\frac{1}{1-\theta} - \frac{\alpha\varphi}{1+\varphi-\epsilon^{c}_{w}}\right)\epsilon^{k/y}_{R^b}, \tag{A.1.9}$$

$$\epsilon^{k}_{\rho} = \left(\frac{1}{1-\theta} - \frac{\alpha\gamma\varphi}{1+\varphi-\epsilon^{c}_{w}}\right)\epsilon^{k/y}_{\rho}. \tag{A.1.10}$$

Finally, note that the inequality $\epsilon^{c}_{w} < \varphi(1-\alpha)$ implies that $\epsilon^{k}_{R^b} > 0$ and $\epsilon^{k}_{\rho} < 0$ for any parameters. ■

A.2 Proof of Proposition 3

The elasticity of consumption taxes with respect to x can be written as

$$\epsilon^{T^c}_{x} = \epsilon^{c/y}_{x} + \epsilon^{y}_{x} = \epsilon^{c/y}_{x} + \frac{\theta}{1-\theta}\epsilon^{k/y}_{x} + \epsilon^{n}_{x}. \tag{A.2.1}$$

Using equations (16) and (17), we obtain the relation between ϵ^{n}_{x} and $\epsilon^{c/y}_{x}$:

$$\epsilon^{c/y}_{x} = \left(-1 - \frac{1}{\varphi}\left(1-\epsilon^{c}_{w}\right)\right)\epsilon^{n}_{x}. \tag{A.2.2}$$

By substituting equations (A.2.2) and (A.1.5)-(A.1.8) into (A.2.1) we get

$$\epsilon^{T^c}_{R^b} = \left(\frac{\theta}{1-\theta} + \frac{\alpha\left(1-\epsilon^{c}_{w}\right)}{1+\varphi-\epsilon^{c}_{w}}\right)\epsilon^{k/y}_{R^b}, \tag{A.2.3}$$

$$\epsilon^{T^c}_{\rho} = \left(\frac{\theta}{1-\theta} + \frac{\alpha\gamma\left(1-\epsilon^{c}_{w}\right)}{1+\varphi-\epsilon^{c}_{w}}\right)\epsilon^{k/y}_{\rho}. \tag{A.2.4}$$

The elasticity of capital income tax with respect to x is

$$\epsilon^{T^k}_{x} = -\frac{r}{r-\delta}\epsilon^{k/y}_{x} + \epsilon^{k}_{x}. \tag{A.2.5}$$

Therefore, elasticities of capital tax with respect to R^b and ρ are

$$\epsilon_{R^b}^{T^k} = \left(\frac{\theta}{1-\theta} - \frac{\alpha\varphi}{1+\varphi-\epsilon_w^c} - \frac{r}{r-\delta} \right) \epsilon_{R^b}^{k/y}, \tag{A.2.6}$$

$$\epsilon_{\rho}^{T^k} = \left(\frac{\theta}{1-\theta} - \frac{\alpha\gamma\varphi}{1+\varphi-\epsilon_w^c} - \frac{r}{r-\delta} \right) \epsilon_{\rho}^{k/y}. \tag{A.2.7}$$

As far as $T^n = \tau^n wn = \tau^n (1-\theta) y$, the impact of financial repression on labor income tax corresponds to the impact of repression on output.

Since we know how financial repression affects each taxation, we can derive an elasticity of sum of ordinary taxes with respect to R^b and ρ, respectively

$$\epsilon_{R^b}^{T} = \left(\frac{\theta}{1-\theta} - \frac{\alpha\varphi}{1+\varphi-\epsilon_w^c} + \alpha\frac{T^c}{T} - \frac{\tau^k\theta y}{T} \right) \epsilon_{R^b}^{k/y}, \tag{A.2.8}$$

$$\epsilon_{\rho}^{T} = \left(\frac{\theta}{1-\theta} - \frac{\gamma\alpha\varphi}{1+\varphi-\epsilon_w^c} + \gamma\alpha\frac{T^c}{T} - \frac{\tau^k\theta y}{T} \right) \epsilon_{\rho}^{k/y}. \tag{A.2.9}$$

■

A.3 Proof of Proposition 4

Taking partial derivative of $b = \frac{\rho}{1-\rho}k$,

$$\frac{\partial b}{\partial \rho} = \frac{b}{\rho(1-\rho)} + b\epsilon_{\rho}^{k}. \tag{A.3.1}$$

and using equations (A.1.4) and (A.1.10), we get

$$\frac{\partial b}{\partial \rho} = \frac{b}{\rho(1-\rho)} \left(1 - \frac{(\beta^{-1}-R^b)\, b}{(1-\tau^k)\,\theta y} \left(\frac{1}{1-\theta} - \gamma\frac{\alpha\varphi}{1+\varphi-\epsilon_w^c} \right) \right). \tag{A.3.2}$$

Using equation (15), we can see that $\frac{\partial b}{\partial \rho} > 0$ iff

$$\epsilon_w^c < 1 + \varphi \left(1 + \frac{\alpha(1-\theta)\gamma\rho}{1-\rho-\theta+\gamma(1-\theta)} \right). \tag{A.3.3}$$

■

A.4 Proof of Proposition 5

Derive the elasticity of T^b with respect to R^b:

$$\epsilon_{R^b}^{T^b} = -\frac{R^b}{\beta^{-1}-R^b} \left[1 - \frac{1}{(1-\tau^k)\,\theta} \frac{T^b}{y} \left(\frac{1}{1-\theta} - \epsilon_{k/y}^{n} \right) \right], \tag{A.4.1}$$

where $\epsilon^n_{k/y} = \frac{\alpha\varphi}{1+\varphi-\epsilon^c_w}$.

The ratio of net revenue from financial repression to output is:

$$\frac{T^b}{y} = \theta\left(1-\tau^k\right)\frac{\frac{\rho}{1-\rho}\left(\beta^{-1}-R^b\right)}{\beta^{-1}-1+\delta\left(1-\tau^k\right)+\frac{\rho}{1-\rho}\left(\beta^{-1}-R^b\right)}. \tag{A.4.2}$$

It is easy to conclude that $\frac{\partial\frac{T^b}{y}}{\partial R^b} < 0$ and $\frac{\partial\frac{T^b}{y}}{\partial\rho} > 0$.

At the same time,

$$\epsilon^n_{k/y} = \frac{\alpha\varphi}{1+\varphi\eta^{-1}+\varphi\left(1-\eta^{-1}\right)\alpha}. \tag{A.4.3}$$

Taking into account equations (18) and (15), we can argue that $\frac{\partial\epsilon^n_{k/y}}{\partial R^b} > 0$.

Therefore, since $\frac{\partial\frac{T^b}{y}}{\partial R^b} < 0$ and $\frac{\partial\epsilon^n_{k/y}}{\partial R^b} > 0$, the expression inside the square brackets in (A.4.1) is increasing in R^b. Thus, the elasticity of net revenue from financial repression is also increasing in R^b. The semi-elasticity can be either positive or negative, depending on the sign of expression inside the brackets. So, the semi-elasticity is negative iff $\epsilon^c_w < 1+\varphi+\alpha\varphi\frac{T^b/y}{(1-\tau^k)\theta-(1-\theta)^{-1}T^b/y}$.

On the other hand, the elasticity of net revenue from financial repression with respect to ρ is

$$\epsilon^{T^b}_\rho = (1-\rho)^{-1}\left[1-\frac{1}{\left(1-\tau^k\right)\theta}\frac{T^b}{y}\left(\frac{1}{1-\theta}-\gamma\epsilon^n_{k/y}\right)\right]. \tag{A.4.4}$$

The expression inside the square brackets in (A.4.6.) is decreasing in ρ. Indeed, using equation (A.4.2), we can state that $\frac{\partial(1-\rho)\frac{T^b}{y}}{\partial\rho} > 0$. Next, note that $\frac{\partial(1-\rho)^{-1}\gamma\epsilon^n_{k/y}}{\partial\rho} < 0$.

As ρ tends to 0 and one, the expression tends to 1. As ρ tends to 1 , the expression tends to $1-\frac{1}{1-\theta} < 0$. Similar to the previous part of the proof, the elasticity of T^b with respect to ρ is positive iff $\epsilon^c_w < 1+\varphi+\gamma\alpha\varphi\frac{T^b/y}{(1-\tau^k)\theta-(1-\theta)^{-1}T^b/y}$. ■

A.5 Proof of Proposition 6

Write various taxes-to-output ratios:

$$\frac{T^c}{y} = \tau^c\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c},$$

$$\frac{T^n}{y} = \tau^n\left(1-\theta\right),$$

$$\frac{T^k}{y} = \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right),$$

$$\frac{T^b}{y} = \rho\left(1/\beta-R^b\right)\frac{\left(1-\theta\right)\left(1-\tau^n\right)}{1/\beta-1}\frac{\alpha}{1-\alpha},$$

$$\frac{\hat{T}^b}{y} = \rho\left(1-\theta\right)\left(1-\tau^n\right)\frac{\alpha}{1-\alpha}$$

$$\frac{T}{y} = \frac{T^c}{y} + \frac{T^n}{y} + \frac{T^k}{y}.$$

First, partial derivatives of T^b:

$$\frac{\partial T^b}{\partial R^b} = \frac{b}{(1-\tau^k)\theta} \times \left[\frac{T^b}{y} \frac{1}{1-\theta} - \frac{T^b}{y} \frac{\alpha\varphi}{1+\varphi-\epsilon_w^c} - \left(1-\tau^k\right)\theta \right], \tag{A.5.1}$$

$$\frac{\partial T^b}{\partial \rho} = -\frac{(\beta^{-1}-R^b)\, b}{\rho(1-\rho)(1-\tau^k)\theta} \times \left[\frac{T^b}{y} \frac{1}{1-\theta} - \frac{T^b}{y} \frac{\gamma\alpha\varphi}{1+\varphi-\epsilon_w^c} - \left(1-\tau^k\right)\theta \right]. \tag{A.5.2}$$

By combining $(A.5.1)$ and $(A.5.2)$ and using the definition of marginal rate of substitution for the case of constant T^b , we can derive conditions when instruments of financial repression R^b and ρ are complements

$$\text{sign}\left(\frac{d\rho}{dR^b}\right) = \text{sign}\left(\frac{\frac{T^b}{y}\frac{1}{1-\theta} - \frac{T^b}{y}\frac{\alpha\varphi}{1+\varphi-\epsilon_w^c} - (1-\tau^k)\theta}{\frac{T^b}{y}\frac{1}{1-\theta} - \frac{T^b}{y}\frac{\gamma\alpha\varphi}{1+\varphi-\epsilon_w^c} - (1-\tau^k)\theta} \right). \tag{A.5.3}$$

Since $\frac{T^b}{y} > 0$ and $\gamma < 1$, equation (A.5.3) implies that $\frac{d\rho}{dR^b}|_{T^b=const} < 0$ iff both inequalities (A.5.4) and (A.5.5) hold

$$\epsilon_w^c > 1+\varphi+\alpha\varphi \frac{\rho\left(1/\beta - R^b\right)\frac{(1-\theta)(1-\tau^n)}{1/\beta-1}\frac{\alpha}{1-\alpha}}{(1-\tau^k)\theta - \rho\left(1/\beta - R^b\right)\frac{1-\tau^n}{1/\beta-1}\frac{\alpha}{1-\alpha}} \equiv \underline{\nu}, \tag{A.5.4}$$

$$\epsilon_w^c < 1+\varphi+\gamma\alpha\varphi \frac{\rho\left(1/\beta - R^b\right)\frac{(1-\theta)(1-\tau^n)}{1/\beta-1}\frac{\alpha}{1-\alpha}}{(1-\tau^k)\theta - \rho\left(1/\beta - R^b\right)\frac{1-\tau^n}{1/\beta-1}\frac{\alpha}{1-\alpha}} \equiv \overline{\nu}. \tag{A.5.5}$$

Second, the partial derivatives for the sum of ordinary taxes are

$$\begin{aligned} \frac{\partial T}{\partial R^b} = \frac{b}{(1-\tau^k)\theta} \Bigg[& \left(\frac{T^c}{y} + \frac{T^n}{y} + \frac{T^k}{y}\right)\frac{\theta}{1-\theta} \\ & - \left(\frac{T^k}{y} + \frac{T^n}{y} - \frac{1-\epsilon_w^c}{\varphi}\frac{T^c}{y}\right)\frac{\alpha\varphi}{1+\varphi-\epsilon_w^c} - \tau^k\theta \Bigg], \end{aligned} \tag{A.5.6}$$

$$\begin{aligned} \frac{\partial T}{\partial \rho} = -\frac{(\beta^{-1}-R^b)\, b}{\rho(1-\rho)(1-\tau^k)\theta} \Bigg[& \left(\frac{T^c}{y} + \frac{T^n}{y} + \frac{T^k}{y}\right)\frac{\theta}{1-\theta} \\ & - \left(\frac{T^k}{y} + \frac{T^n}{y} - \frac{1-\epsilon_w^c}{\varphi}\frac{T^c}{y}\right)\frac{\gamma\alpha\varphi}{1+\varphi-\epsilon_w^c} - \tau^k\theta \Bigg]. \end{aligned} \tag{A.5.7}$$

$\frac{d\rho}{dR^b}|_{T=const}$ is negative iff $\underline{\upsilon} < \epsilon_w^c < \overline{\upsilon}$, where

$$\begin{aligned} \underline{\upsilon} \equiv 1+\varphi+\alpha\varphi\cdot\min\Bigg\{ & \frac{\tau^c\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta(1-\rho)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n(1-\theta)}{\tau^k\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta(1-\rho)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n(1-\theta)\right)}; \\ & \gamma\frac{\tau^c\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta(1-\rho)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n(1-\theta)}{\tau^k\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\alpha\gamma}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta(1-\rho)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n(1-\theta)\right)} \Bigg\}, \end{aligned}$$

$$\overline{\upsilon} \equiv 1{+}\varphi{+}\alpha\varphi{\cdot}\max\left\{\frac{\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right)}{\tau^k\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right)\right)};\right.$$
$$\left.\gamma\frac{\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right)}{\tau^k\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\alpha\gamma}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right)\right)}\right\}.$$

Third, write the steady-state government budget constraint as

$$g = T^c + T^k + T^n + \widehat{T}^b, \tag{A.5.8}$$

where $\widehat{T}^b = (1 - R^b)\, b$ is the gross revenue from financial repression.

Write partial derivatives $\frac{\partial g}{\partial R^b}$ and $\frac{\partial g}{\partial \rho}$:

$$\frac{\partial g}{\partial R^b} = \frac{b}{(1-\tau^k)\theta}\left[\left(\frac{T^c}{y} + \frac{T^k}{y} + \frac{T^n}{y} + \frac{1}{\theta}\frac{\widehat{T}^b}{y}\right)\frac{\theta}{1-\theta}\right.$$
$$\left. - \left(\frac{T^k}{y} + \frac{T^n}{y} + \frac{\widehat{T}^b}{y} - \frac{1-\epsilon^c_w}{\varphi}\frac{T^c}{y}\right)\frac{\alpha\varphi}{1+\varphi-\epsilon^c_w} - \theta\right], \tag{A.5.9}$$

$$\frac{\partial g}{\partial \rho} = -\frac{(\beta^{-1} - R^b)\, b}{\rho\,(1-\rho)\,(1-\tau^k)\,\theta}\left[\left(\frac{T^c}{y} + \frac{T^k}{y} + \frac{T^n}{y} + \frac{1}{\theta}\frac{\widehat{T}^b}{y}\right)\frac{\theta}{1-\theta}\right.$$
$$\left. - \left(\frac{T^k}{y} + \frac{T^n}{y} + \frac{\widehat{T}^b}{y} - \frac{1-\epsilon^c_w}{\varphi}\frac{T^c}{y}\right)\frac{\gamma\alpha\varphi}{1+\varphi-\epsilon^c_w} - \left(\left(1-\tau^k\right)\frac{1-R^b}{\beta^{-1}-R^b} + \tau^k\right)\theta\right]. \tag{A.5.10}$$

Combining (A.5.9) and (A.5.10), we can find $\underline{\sigma}$ and $\overline{\sigma}$ such that

$$\underline{\sigma} = 1 + \varphi$$
$$+\alpha\varphi{\cdot}\min\left\{\frac{\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right) + \rho\left(1-\theta\right)\left(1-\tau^n\right)\frac{\alpha}{1-\alpha}}{\theta - \frac{\tau^c\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right) + \rho\left(1-\tau^n\right)\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right)};\right.$$
$$\left.\frac{\gamma\left(\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right) + \rho\left(1-\theta\right)\left(1-\tau^n\right)\frac{\alpha}{1-\alpha}\right)}{\left(\left(1-\tau^k\right)\frac{1-R^b}{\beta^{-1}-R^b} + \tau^k\right)\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\gamma\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right) + \rho\frac{(1-\theta)(1-\tau^n)}{\theta}\frac{\alpha}{1-\alpha}\right)}\right\},$$

$$\underline{\sigma} = 1 + \varphi$$
$$+\alpha\varphi{\cdot}\max\left\{\frac{\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right) + \rho\left(1-\theta\right)\left(1-\tau^n\right)\frac{\alpha}{1-\alpha}}{\theta - \frac{\tau^c\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right) + \rho\left(1-\tau^n\right)\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right)};\right.$$
$$\left.\frac{\gamma\left(\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right) + \rho\left(1-\theta\right)\left(1-\tau^n\right)\frac{\alpha}{1-\alpha}\right)}{\left(\left(1-\tau^k\right)\frac{1-R^b}{\beta^{-1}-R^b} + \tau^k\right)\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\gamma\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\left(1-\rho\right)\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\left(1-\theta\right) + \rho\frac{(1-\theta)(1-\tau^n)}{\theta}\frac{\alpha}{1-\alpha}\right)}\right\}.$$

Finally, let us define notional government spending as

$$\hat{g} = g + \left(\beta^{-1} - 1\right) b = T^c + T^k + T^n + T^b, \tag{A.5.11}$$

and write partial derivatives:

$$\frac{\partial \hat{g}}{\partial R^b} = \frac{b}{(1-\tau^k)\theta} \times \left[\left(\frac{T^c}{y} + \frac{T^k}{y} + \frac{T^n}{y} + \frac{1}{\theta}\frac{T^b}{y} \right) \frac{\theta}{1-\theta} \right.$$
$$\left. - \left(\frac{T^k}{y} + \frac{T^n}{y} + \frac{T^b}{y} - \frac{1-\epsilon_w^c}{\varphi}\frac{T^c}{y} \right) \frac{\alpha\varphi}{1+\varphi-\epsilon_w^c} - \theta \right], \quad \text{(A.5.12)}$$

$$\frac{\partial \hat{g}}{\partial \rho} = -\frac{(\beta^{-1} - R^b)\, b}{\rho\,(1-\rho)\,(1-\tau^k)\,\theta} \times \left[\left(\frac{T^c}{y} + \frac{T^k}{y} + \frac{T^n}{y} + \frac{1}{\theta}\frac{T^b}{y} \right) \frac{\theta}{1-\theta} \right.$$
$$\left. - \left(\frac{T^k}{y} + \frac{T^n}{y} + \frac{T^b}{y} - \frac{1-\epsilon_w^c}{\varphi}\frac{T^c}{y} \right) \frac{\gamma\alpha\varphi}{1+\varphi-\epsilon_w^c} - \theta \right]. \quad \text{(A.5.13)}$$

$$\text{sign}\left(\frac{d\rho}{dR^b}\right) = \text{sign}\left(\frac{\left(\frac{T^c}{y} + \frac{T^k}{y} + \frac{T^n}{y} + \frac{1}{\theta}\frac{T^b}{y} \right) \frac{\theta}{1-\theta} - \left(\frac{T^k}{y} + \frac{T^n}{y} + \frac{T^b}{y} - \frac{1-\epsilon_w^c}{\varphi}\frac{T^c}{y} \right) \frac{\alpha\varphi}{1+\varphi-\epsilon_w^c} - \theta}{\left(\frac{T^c}{y} + \frac{T^k}{y} + \frac{T^n}{y} + \frac{1}{\theta}\frac{T^b}{y} \right) \frac{\theta}{1-\theta} - \left(\frac{T^k}{y} + \frac{T^n}{y} + \frac{T^b}{y} - \frac{1-\epsilon_w^c}{\varphi}\frac{T^c}{y} \right) \frac{\gamma\alpha\varphi}{1+\varphi-\epsilon_w^c} - \theta} \right) \quad (A.5.14)$$

$\frac{d\rho}{dR^b}\Big|_{g+\frac{1-\beta}{\beta}b=const} < 0$ iff both $\underline{\varsigma} < \epsilon_w^c < \overline{\varsigma}$ inequalities (A.5.15) and (A.5.16) hold

$$\underline{\varsigma} = 1 + \varphi$$
$$+\alpha\varphi\cdot\min\left\{ \frac{\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1 - \delta\,(1-\rho)\,\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\,(1-\theta) + \rho\left(1/\beta - R^b\right)\frac{(1-\theta)(1-\tau^n)}{1/\beta-1}\frac{\alpha}{1-\alpha}}{\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\,(1-\rho)\,\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\,(1-\theta) + \rho\,(1/\beta - R^b)\,\frac{(1-\theta)(1-\tau^n)}{\theta(1/\beta-1)}\frac{\alpha}{1-\alpha}\right)};\right.$$
$$\left.\gamma\frac{\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1 - \delta\,(1-\rho)\,\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\,(1-\theta) + \rho\left(1/\beta - R^b\right)\frac{(1-\theta)(1-\tau^n)}{1/\beta-1}\frac{\alpha}{1-\alpha}}{\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\gamma\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\,(1-\rho)\,\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\,(1-\theta) + \rho\,(1/\beta - R^b)\,\frac{(1-\theta)(1-\tau^n)}{\theta(1/\beta-1)}\frac{\alpha}{1-\alpha}\right)}\right\},$$

$$\underline{\varsigma} = 1 + \varphi$$
$$+\alpha\varphi\cdot\max\left\{ \frac{\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1 - \delta\,(1-\rho)\,\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\,(1-\theta) + \rho\left(1/\beta - R^b\right)\frac{(1-\theta)(1-\tau^n)}{1/\beta-1}\frac{\alpha}{1-\alpha}}{\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\,(1-\rho)\,\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\,(1-\theta) + \rho\,(1/\beta - R^b)\,\frac{(1-\theta)(1-\tau^n)}{\theta(1/\beta-1)}\frac{\alpha}{1-\alpha}\right)};\right.$$
$$\left.\gamma\frac{\tau^c \frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1 - \delta\,(1-\rho)\,\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\,(1-\theta) + \rho\left(1/\beta - R^b\right)\frac{(1-\theta)(1-\tau^n)}{1/\beta-1}\frac{\alpha}{1-\alpha}}{\theta - \frac{\theta}{1-\theta}\left(\tau^c\frac{\theta+(1-\theta)\gamma\alpha}{\theta}\frac{1-\theta}{1-\alpha}\frac{1-\tau^n}{1+\tau^c} + \tau^k\theta\left(1-\delta\,(1-\rho)\,\frac{1-\tau^n}{1/\beta-1}\frac{1-\theta}{\theta}\frac{\alpha}{1-\alpha}\right) + \tau^n\,(1-\theta) + \rho\,(1/\beta - R^b)\,\frac{(1-\theta)(1-\tau^n)}{\theta(1/\beta-1)}\frac{\alpha}{1-\alpha}\right)}\right\}.$$

■